tion), have no connection with evolution except that they may impede the process. If all organisms came from one original intergenerating stock, deriving its food from the inorganic world, and from the dead individuals of its own kind, how far could evolution have progressed without any formation of separate species? What would now become of the organic world if isolation and selection ceased and all the separate species were merged in one? When I say that there may be evolution without isolation I mean without *additional isolation*. I do not mean that the undoing of all the effects produced by vital forces making isolation complete, though the different genera occupy the same district, would be an advance step in evolution. On the contrary, I think that such an undoing would mean the crumbling of the whole fabric of the organic world.

Is not racial evolution a term that we can rightly and wisely apply to all the processes of change in organisms affecting characters that are subject to the laws of heredity and variation? May it not be applied to all changes in races and species resulting, not only from the action and reaction of members of the same species upon each other, but also from the action and reaction between individuals or groups and their environments? May not evolution be either divergent, convergent or parallel? either progressive, or retrogressive? May it not take place without any change in the environment, and in that sense be spontaneous; and may it not be due to vital action stimulated, guided, and controlled by external conditions?

HONOLULU, HAWAII. JOHN T. GULICK.

RETROACTIVE SELECTION[1]

IN his contribution to THE AMERICAN NATURALIST of July, Professor Marshall makes some statements which I wish to correct. Among other things he says:

[1] "Retroactive Selection" is a term used by me to designate the modifications of each selection by the selections which follow. Thus, selection No. 2 modifies selection No. 1 by eliminating part of the animals which selection No. 1 retained as breeders. Selection No. 3 modifies selection No. 2 by eliminating some of the animals which selection No. 2 retained, and this in turn causes a second modification in selection No. 1 by eliminating more of those originally retained. In the same way, selection No. 4 modifies selections Nos. 1, 2 and 3; selection No. 5 modifies selections Nos. 1, 2, 3 and 4; and so on.

A study of retroactive selection is a study of the successive modifications of early selections by the retroactive effect of later ones.

Mr. Redfield would say that the effects of environment are inherited.

It would require too much space to explain how this misapprehension of my position became prevalent. It is sufficient for the present purposes to say that it is a misapprehension, and that I am not taking the ground that the effects of environment are inherited—at least not in any sense in which a plain statement to that effect would imply.

What I am interested in at the present time is learning what explanation others would give of certain facts which I have dug out of records. One of these facts relates to the ages of sires in pedigrees of 2:10 trotters, or trotters in general, and as this subject has already been opened it appears a fitting one to continue.

After quoting what I had to say about sires appearing older and older the further we go back in the best pedigrees, Professor Marshall says:

The evident conclusion from this statement is that our best horses come from an increasing popularity of *younger* sires.

The error in this statement is more in what it implies than in what it actually says. Young sires are popular and have been popular during the entire history of breeding the trotter. Many very fast trotters have come from such sires, but a consideration of those raises a collateral question which it is better to postpone to a later date. What actually occurs in the breeding of trotters may be described as follows:

Assume some thousands of animals belonging to the trotting stock as it existed in this country, say seventy-five years ago. Using concrete numbers for illustration, we will say that out of these horses one thousand stallions are selected for breeding purposes to produce the next generation. We will designate these one thousand stallions as the first generation and the first selection in a process of selection which we will follow through several generations as it has actually been employed by the breeders of trotters. These one thousand stallions were sons of sires which were, on the average, 10.4 years old at the time the sons were born. It may be added here that this 10.4 years between generations in the male line is the approximate average as it has existed at all times within the known history of the trotter. A detailed investigation of the "Trotting Register" for different periods shows that at no time have ordinary breeding operations varied from this except in the value of the decimal.

The one thousand stallions of the first generation produce the second, of which some ten thousand or more are stud colts. Out of these a second selection of one thousand stallions is made for breeding purposes to produce the third generation. The stallions of this second selection are sons of sires averaging 10.4 years of age, and the selection is based principally upon the performances of their sisters, their cousins and their aunts. Don't fail to note the fact that until very recent years, stallions were rarely selected for breeding purposes because of their own performances. Horse history is full of the assertions by breeders that stallions intended for breeding should never be raced.

Now we come to the critical point to which close attention should be given. The one thousand stallions of the second selection are not the sons of the full one thousand stallions of the first selection—one son for each sire. On the contrary, some sires in the first selection are represented by numerous sons in the second selection, while other sires in the first selection are not represented at all. In other words, about one-half of the first selection of sires is cut out by the second selection. This weeding out of the sires of the first selection is done largely *after* the sires themselves are dead, and is based upon the performances of animals other than the sires of either generation.

When we examine the sires of the first selection after the weeding-out process involved in the second selection, we find the sires eliminated by the second selection to have been principally, though not wholly, sons of young sires; and that the sires which are retained to breed on in the male line to the third generation, are principally, though not wholly, sons of old sires. The net result of cutting off part of the original selection by the second selection is that the 500 left are sons of sires averaging about 12.5 years of age.

In due course of time a third selection of one thousand stallions is made from the third generation for the purpose of producing the fourth, and they in turn are sons of sires averaging 10.4 years of age. But all of the stallions of the second selection are not represented in the third selection. In fact about one half of them are cut off, with the result that the 500 which are left in the second selection, after making the third selection, are sons of sires averaging 12.5 years. Now, when the third selection cut off part of those originally in the second selection it also cut off many lines of descent back to the first

generation. The horses which were thus cut out of the first selection by the third selection, occurring some thirty or more years later, were more largely sons of young sires than sons of old sires, with the net result that those left were sons of sires averaging 13.5 years of age.

This is the process which has been going on from generation to generation—each selection reducing the number of horses in earlier generations which are left to breed on to later generations. Chester proved some years ago that all known standard trotters were descended in the male line from one or another of no more than seventeen foundation horses. While these all stand as having been progenitors of trotters, the majority of them represent what are now extinct families, so that the trotters as now bred come in the male line from only six or eight horses.

The process set forth explains how it comes about that, in examining the pedigrees of any trotting stock, the further we go back in those pedigrees the older the sires appear, but it does not explain *why* a late selection cuts off young sires and preserves old sires of earlier generations.

That is the supreme question I am asking biologists. I have asked it in several forms before without getting a reply commensurate with what I consider the importance of the question. It is hoped that the present form, accompanied by the explanation upon which the form is based, will bring forth a genuine effort to explain *the cause* of these remarkable facts.

CASPER L. REDFIELD.

THE LOGIC OF CHANCE IN PROBLEMS OF GENETICS

THE literature at present appearing dealing with problems of genetics and evolution teems with uncertainty and inexactness in the use and misuse of the word "chance." Some definite understanding of the significance of the concept as a legitimate category of scientific reasoning seems desirable. At any mention of the word chance, some listener is sure to rise in protest with the old adage—"There is no chance, it's only your ignorance." The acceptance or the rejection of this bit of prophecy depends on the ultimate postulate of the absolute uniformity of nature. The truth of this postulate is a metaphysical question with which the ordinary student of genetics is not concerned. He is reminded of the fact that Darwin and all after him have